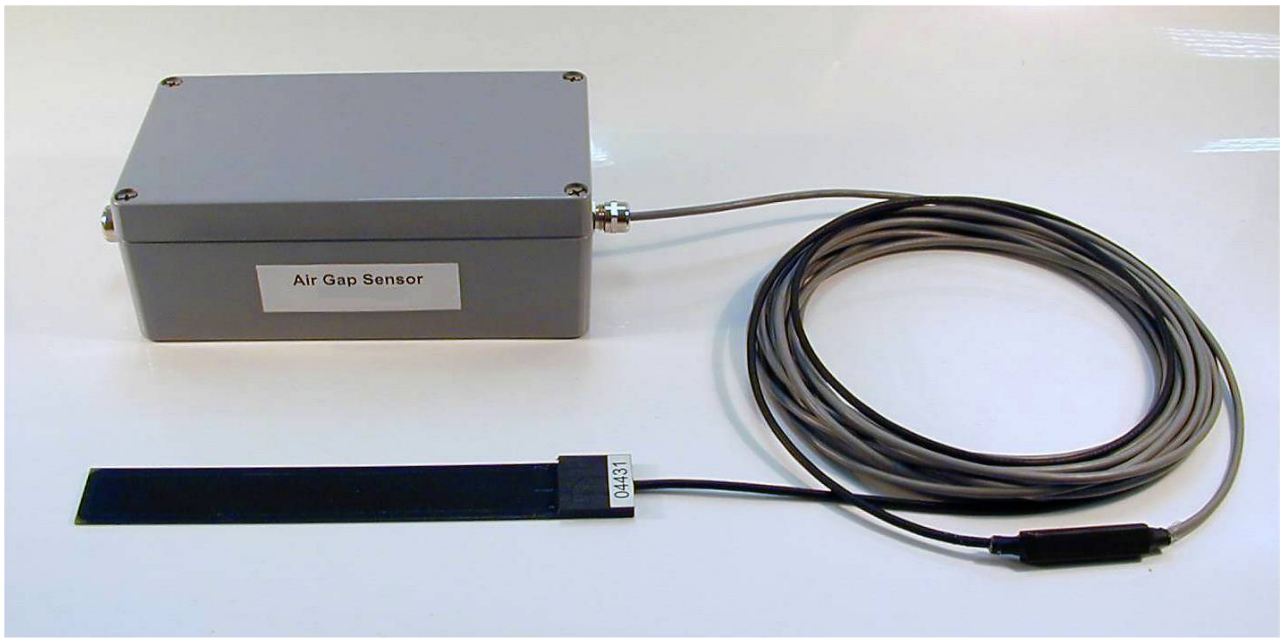
Air Gap Sensor
AGS
Installation and user manual



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THIS INSTRUCTION MANUAL SHOULD BE READ CAREFULLY AND THE SAFETY INSTRUCTIONS OBSERVED BEFORE INSTALLING, CALIBRATING OR USING THE EQUIPMENT DESCRIBED HEREIN.

- Installation and maintenance must be performed by qualified personnel familiar with the construction, operation, and hazards involved with the equipment.

- Installation and maintenance must be performed with the control out of operation and disconnected from all sources of power

- Care should be taken when servicing electrostatic sensitive components. The manufacturer's recommendations for these components should be followed.

- Ventilation passages should be kept open.

- The means employed for grounding or insulating the equipment from ground should be checked to assure its integrity.

- Care must be taken to avoid damaging any delicate components and to avoid displacing dust, dirt, or debris in a way that permits it to enter or settle into parts of the control equipment.

- Enclosures should be inspected for evidence of deterioration. Accumulated dust and dirt should be removed from the top of the enclosures before opening doors or removing covers.

1. Overview

High accuracy, non contact, capacitive type distance measuring transducer for measuring air-gap in air-cooled generators and electric motors

Low profile sensor with triaxial cable, preamplifier and shielded cable

High stability carbon particle semiconductive electrode

DC/DC insulated power supply

Optocoupler insulated output, 0…20 mA or 4...20mA

Wide operating temperature range:
-Sensor: 0...125℃,
-Signal Conditioner: 0...55℃

Immune to magnetic fields, dust and oil vapours, EMI, RFI

2. Application

Capacitive type Air Gap Sensor for air-cooled generators and electrical motors.
It shall not be installed in hydrogen-cooled turbo-alternators.

Linear measuring range: **AGS-10: 2 to 10 mm**
AGS-15: 3 to 15 mm
AGS-25: 5 to 25 mm
AGS-50: 10 to 50 mm
(other ranges available per request)

High sensitivity, high resolution (up to 50 microns with oversampling).
Measuring of air-gap, rotor vibrations, rotor symmetry, power angle…

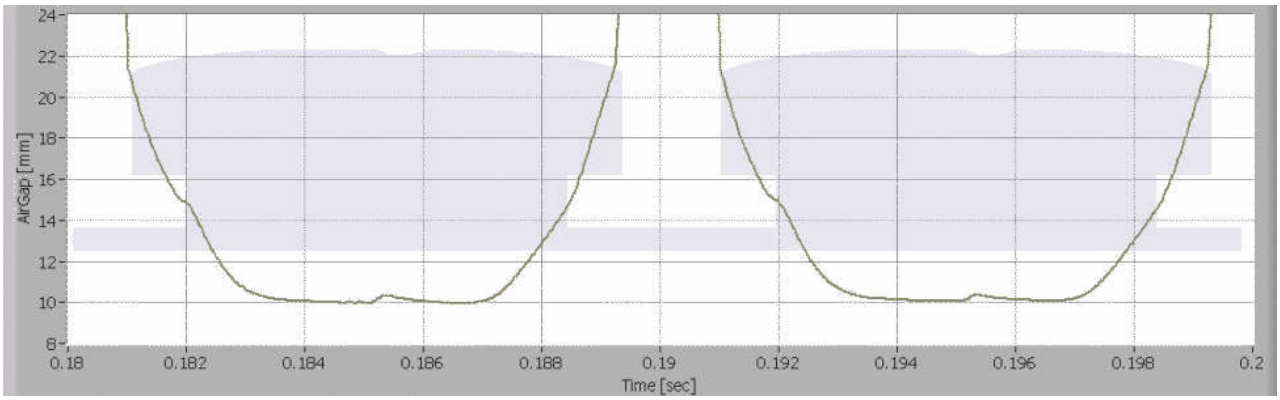


Figure 1: Image of Air Gap signal, zoom of two poles only

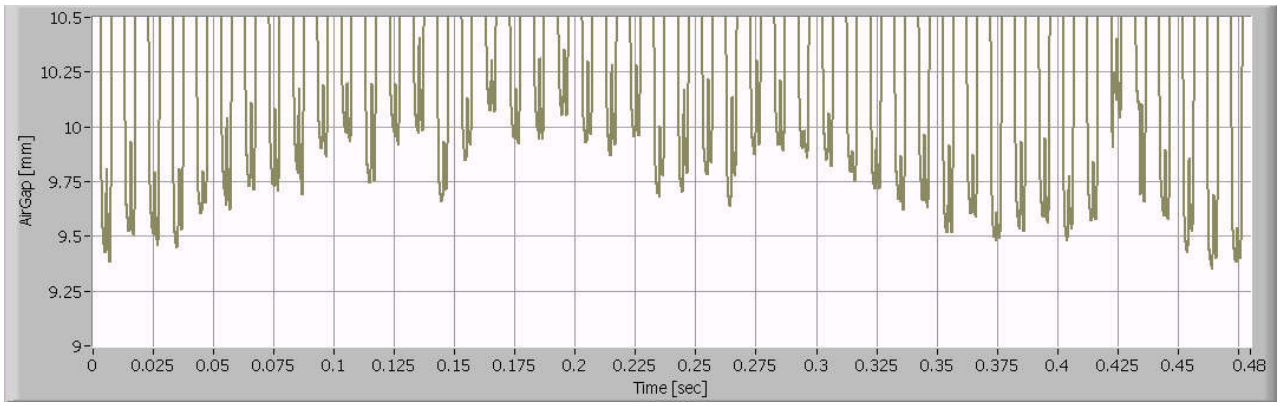


Figure 2: Air Gap signal

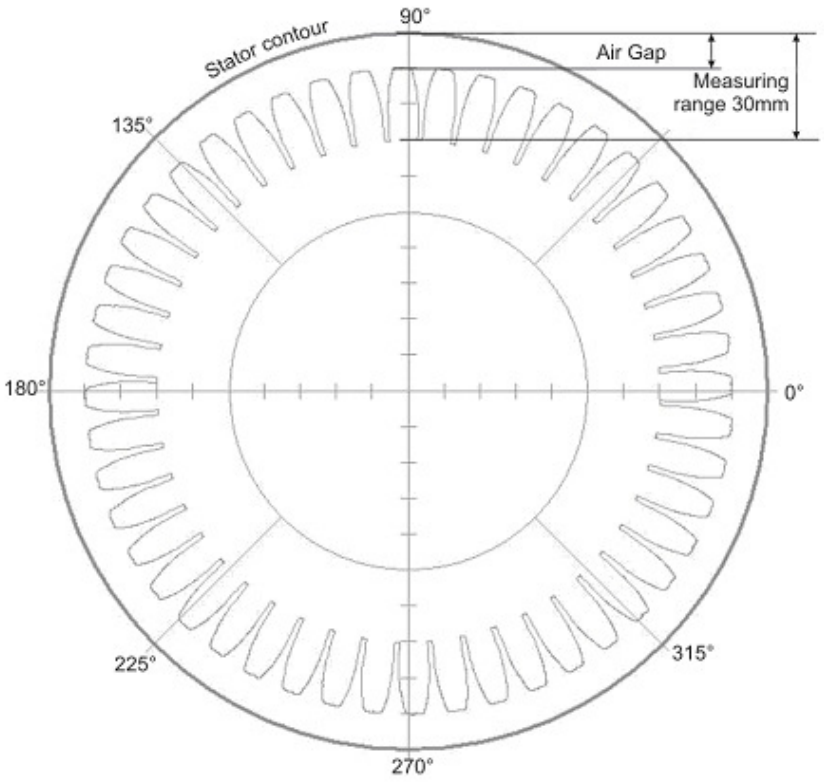


Figure 3: Image of Air Gap signal, polar data

3. Technical specifications

	AGS-10	AGS-15	AGS-25	AGS-50
Probe dimensions	93x32x1,2mm	135x32x1,2mm	232x32x2,3mm	175x60x2,3mm
Preamplifier cable	10m		12m	
Magnetic flux density	±1,8 Tesla			
Probe operating temperature	0…125℃			
Probe relative humidity	95% non condensing			
Probe immunity	magnetic fields, dust and oil vapours			
Probe weight (with cable):			330gr.	
Linear measuring range	2...10mm	3...15mm	5...25mm	10...50mm
Measurement tolerance (typical)	±1% at 6mm	±1% at 8mm	±1,5% at 15mm	±3% at 30mm
Linearity (typical) FSD	<±1,5%	<±1,5%	<±3%	<±5%
Repeatability	<±0,3%			
Output pole profile	0…20mA, (0mA=0mm), or 4...20mA (4mA=0mm) with 500 Ohm termination resistor 0...10V (2...10V), opto-insulated			
Sensitivity (0...20mA output)	2mA/mm	1,33mA/mm	0,8mA/mm	0,4mA/mm
Sensitivity (0...10V output)	1V/mm	0,667V/mm	0,4V/mm	0,2V/mm
Sensitivity (4...20mA output)	1,6mA/mm	1,067mA/mm	0,64mA/mm	0,32mA/mm
Sensitivity (2...10V output)	0,8V/mm	0,533V/mm	0,32V/mm	0,16V/mm
Typical frequency response:	0...1000Hz, (-3dB) other bandwidth optional			
Power input	+24Vdc, ±10%, 0,15A max.			
Warm-up time	20...30 min.			
Operating temperature	0…55℃			
Storage temperautre	-20…85℃			
Relative humidity	95% non condensing			
Vibration	IEC 68 2.27, 5 g peak, 10 Hz to 150 Hz			
Shock	IEC 68 2.27, 15 g peak, 11ms			
Mech. dimensions	220 × 120 × 80 mm w/o cable inlets			
Case protection class	IP66			
Weight	AGS 350gr. AGSC 1500g			

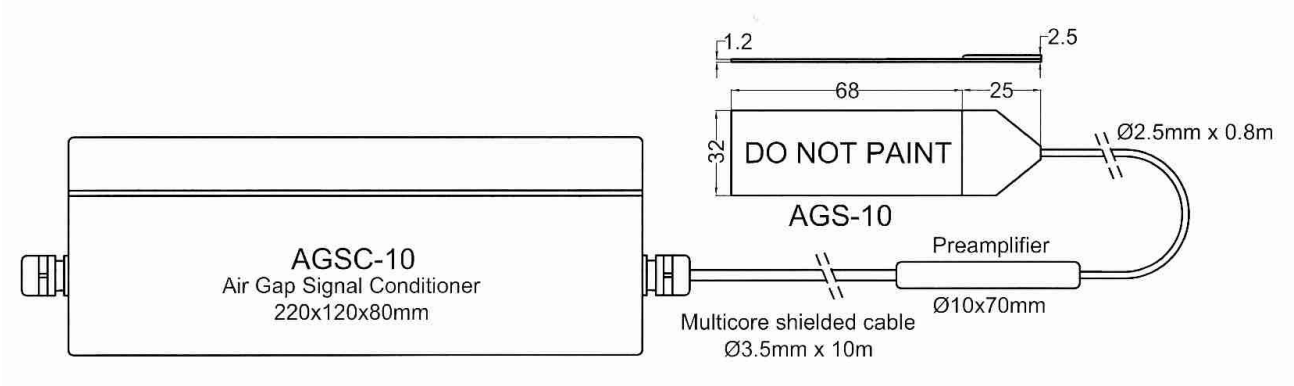


Figure 4: AGS-10 outline drawing

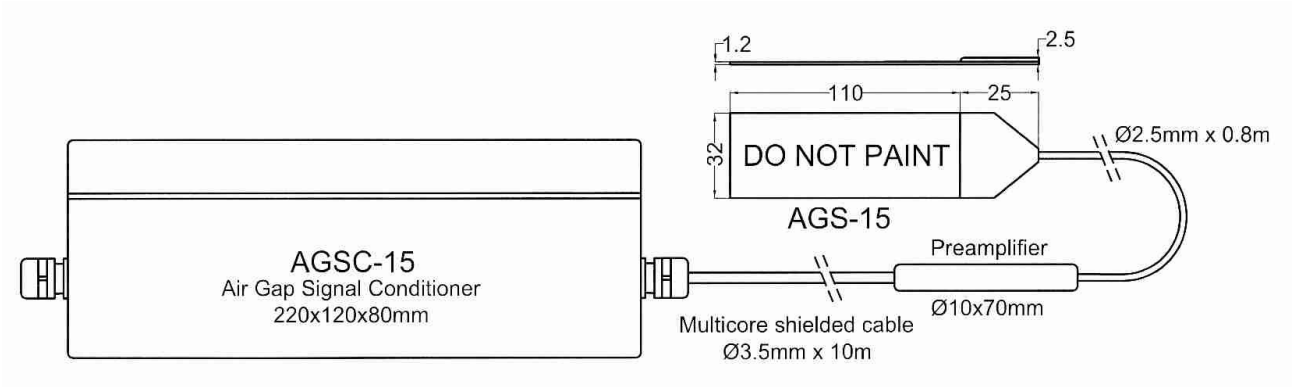


Figure 5: AGS-15 outline drawing

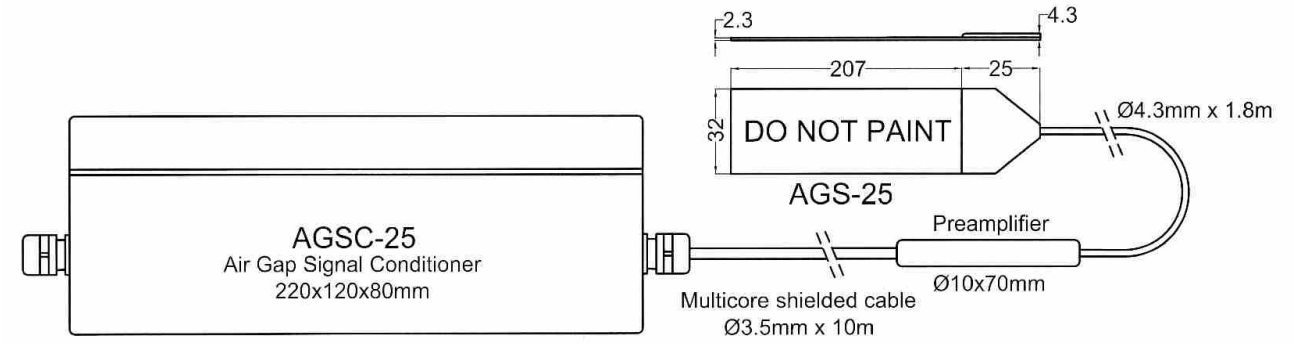


Figure 6: AGS-25 outline drawing

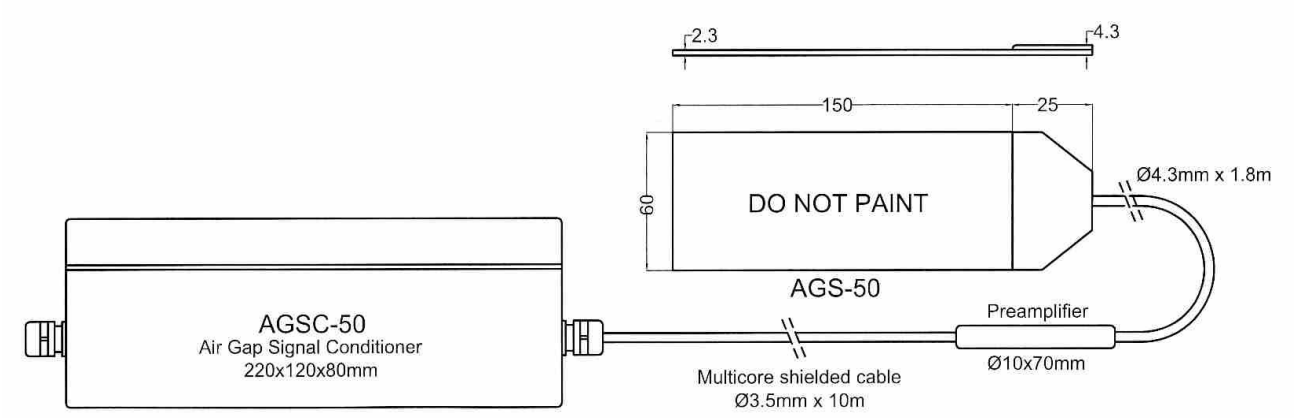


Figure 7: AGS-50 outline drawing

4. Instalation instructions

4.1. AGS Signal Conditioner unit installation guide

Figure 8: The Conditioner unit AGSC

4.2. Apropriate location for AGS Signal Conditioner unit

- up to 10 meters from the sensor probe, up to 100 meters from acquisition unit (with 0...20mA loop, if voltage output used interference free distance may vary),
- prefer well ventilated, dry area free of vibrations and stray magnetic fields,
- ensure adequate ground for enclosure with minimum lenght of wire,
- ensure access to 24 Vdc Power Supply.

Whenever possible use auxiliary enclosure with door end hinge to additionaly shield Conditioner unit from environmental influences, thermal changes etc.

4.3. Grounding of AGS Signal Conditioner unit

CAUTION: ***Grounding is essential for system operation integrity as well as for protection against hazardous voltages. For best grounding, provide the shortest path possible between the Conditioner unit and the grounded structure.***

WARNING: ***MULTICORE CABLE SHIELD SHALL BE GROUNDED AT ACQUISITION CARD INPUT ONLY. MULTIPLE GROUND POINTS WILL CAUSE NOISE PICK-UP AND CAN DAMAGE CONDITIONER UNIT ELECTRONICS.***

4.4. Power supply connection

Power to AGS Signal Conditioner unit shall be 24VDC, ±10%, 0,15A max. Conditioner unit input has insulated DC-DC converter allowing any pole to be grounded or floating power supply as well as daisy chain of several Conditioner units.

4.5. Calibration

The Sensor head and Signal Conditioner units are factory matched and calibrated for best performance. However if needed, can be calibrated at site. For details please cantact www.mikrotrend.com

4.6. AGS Sensor probe installation guide

CAUTION: The AGSsensor probe shall be handled with care.
Do not apply paint or silicone to the sensor surface.
Never pull or use excessive force on the sensor cable or preamplifier.

The sensor surface is treated with high quality insulation varnish, it shall not be scrached as damage to semiconductive electrodes may occur.

4.7. Placing the sensor

Choose position for Air Gap Sensor probe considering number of sensors and machine poles.
True acurate stator geometry can be obtained with only two **Rotor mounted Air Gap Sensors**, also **True acurate Rotor geometry** can be obtained with only two **Stator mounted Air Gap Sensors.**
(http://www.mikrotrend.com/wrm-wireless-hydrogenerator-rotor-monitor.htm)

If **Wireless Rotor AGS** is not used than good practical results are achieved with:
-4 sensors per generator for diameters of less than 7,5 meters,
-8 sensors per generators with dimeter 7,5…12 meters
-and 12 to 16 sensorsr for larger diameters.

Place sensors on the upper side of the stator as it will have higher excentricity than the lower side. For stator height of more than 1,8 meters Air Gap sensors should be placed on the lower side also.
Sensor shall be glued against stator laminations as deep as practical in the air gap. In general, this is beneath the second ventilation hole. The preamplifier (small black box integrated within the cable) **must** stay outside of the air gap and outside of the endwindings, if possible outside the stator casing.

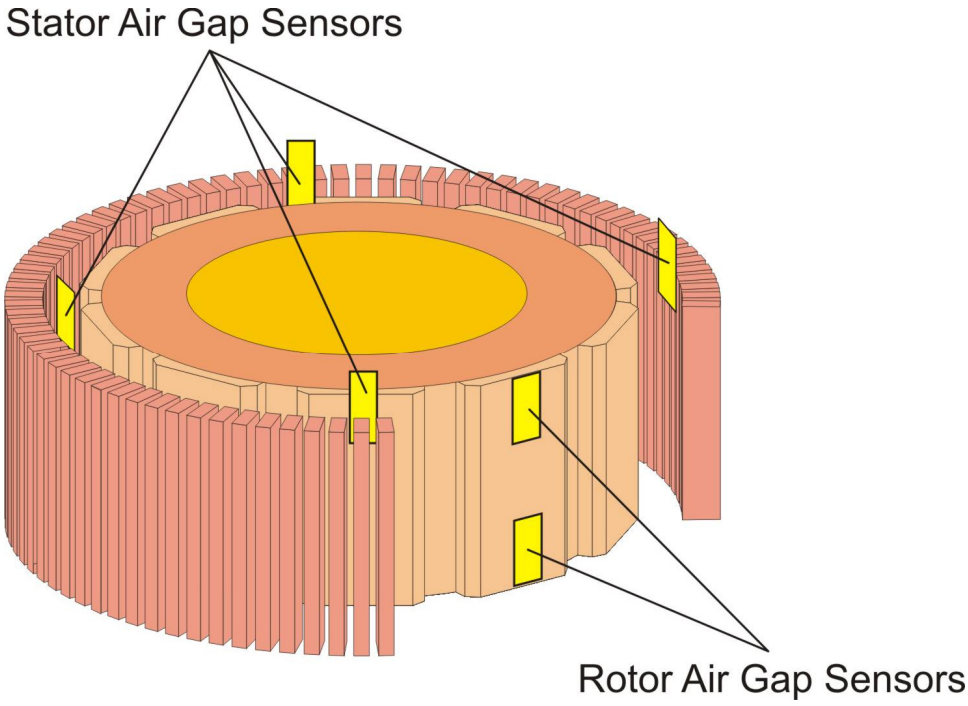


Figure 9: Air Gap Sensor positions

4.8. Preparing the stator surface

Thoroughly clean the stator surface, use allowed cleaning liquid such as **isopropanol** alcohol, disposable cotton rags and fine **non metallic** sandpaper.

WARNING: ***DO NOT USE ACETONE OR OTHER SOLVENTS.***

Use a clean rag moistened with isopropanol over the stator surface to remove oil and carbon deposits.
Epoxy coated or painted stator laminations check for **mechanical stability**. If necessary polish the surface and/or remove unstable particles with **non metallic** sandpaper.

CAUTION: ***Sensor´s bottom surface shall be insulated from stator iron, (a thin coat of Epoxy adhesive will provide suficient insulation).***

After sanding, once again clean stator surface with a rag moistened with isopropanol.
The glue surface should be flat, without protruding laminations, Slight unevenness can be tolerated (± 0.5mm).
Let the isopropanol evaporate at room temperature for about one hour before proceeding with glue application.

4.9. Mounting the sensor

The Air Gap Sensor probe must be aligned with the plane area of the rotor pole. The sensor measuring surface shall always be entirely covered by the pole surface.
We recommend three metods for fastening the sensors, each with different curing times and operating temperatures:

CAUTION: ***Commonly found Epoxid adhesive is not flexible enough. The sensor may come off due to uneven surface tensions during high load periods on generator.***

A. Double sided tape, (quick and easy):

Double Side adhesive 3M Scotch Acrylic Foam Tape VHB 4611. With glue thickness of 1mm, a foam type tape will allow stator unevenness of up to 0,3 mm. Alowed temperatures of 149℃ (for weeks) and short time up to 230℃ (hours).
Clean the back surface of the sensor with a cotton rag moistened with isopropanol.
Place double sided adhesive tape on the back side of the sensor . Remove protective foil and carefully place sensor in position without touching adhesive surface. Using protective gloves or a rag press the sensor firmly against the stator surface. Adhesive is pressure sensitive and reacts on the first applied pressure. The sensor can be put in use imediatelly after gluing, full strenght will be reached after 24 hours.

B. Silicone sealant-adhesive, non-acid (neutral), high temperature

Our prefered mounting technique with high flexibility and high holding force. This is only metod recommended for **Wireless Rotor AGS** where high G-forces are present. Standard operation temperatures from 150℃ up to 1200℃.
A must for locations where stator surface coating has low adhesion to stator laminate. Silicone sealant effectively compensates uneven surface tensions during high load periods on generator thus ensuring stable mounting of the sensor.

With paper adhesive tape, mark border area about 5 mm larger on each side than sensor surface. Apply Silicone sealant about 1mm thick, evenly spread over entire **back surface** of the sensor.
Carefuly place sensor within paper covered opening and firmly press until sealant stops comming out.
Wipe of excess sealant with paper towel until clean and remove adhesive paper border.
Fix the sensor in position with adhesive tape (Power-Tape) for at least 6 hours.Full curing times up to 24 h. shorter with higher ambient moisture.

C: Two component glue (short curing time):

If stator laminate coating is strong and stable and for **continuous operation temperature not exceding 80℃**, You can use two component adhesive type LOCTITE MULTIBOND 330. It is quick and simple application, but flexibility is not great and above mentioned precautions about surface stability and operating temperature shall be observed.
When generator is under heavy load and if surface is not stable enough, the sensor may come off due to tensions which adhesive cannot compensate.
Clean the back surface of the sensor with a rag moistened with alcohol.
Follow manufacturers instructions. Curing times will vary with surface temperature, 50% of the final strength is reached after 10...30 minutes, full strength after approx. 5 hours.

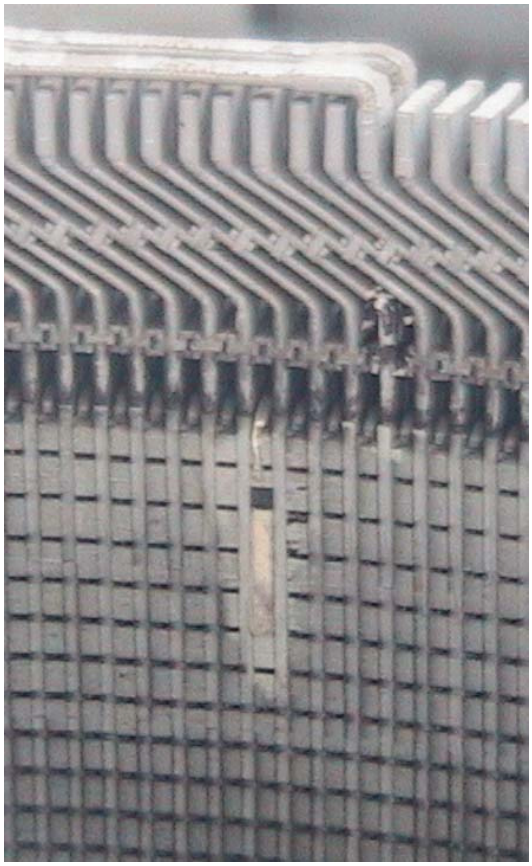


Figure 10: Air Gap Sensor probe installed at Stator pole

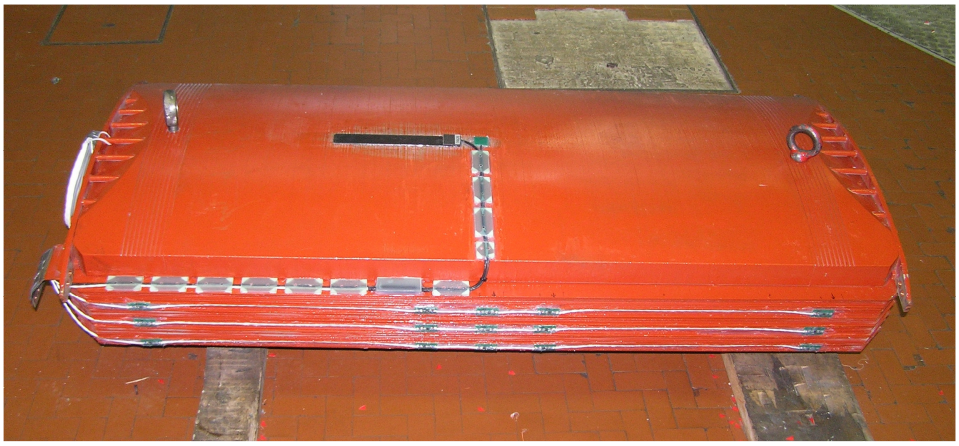


Figure 11: Air Gap Sensor installed at Rotor pole

4.10. True Air-Gap and offset

The output of the signal conditioner provides the distance value between **the sensor surface and rotor pole**.
Offset is the distance between the stator surface and sensor surface, including the thickness of the glue:

Glue thickness+Sensor thickness vill vary with sensor type and mounting metod

True Air-Gap is **sum of measured and offset value**.
Offset compensation shall be made at the monitoring system.

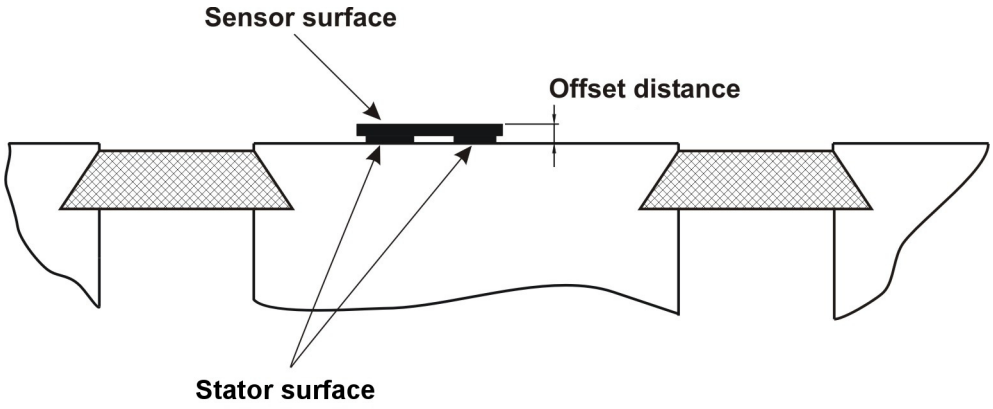


Figure 10: Offset distance

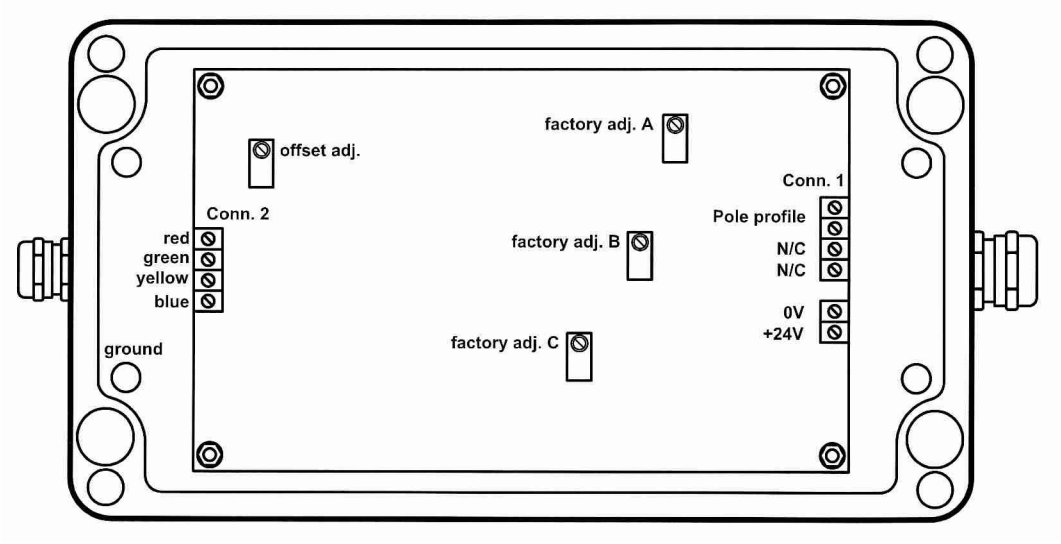


Figure 11: AGSC Adjustments

NOTE: ***Before attempting new offset adjustement let AGSC Conditioner unit be powered for 20...30 minutes.***
Slowly turn trimmer potentiometer labeled **Offset adj.** untill reaching required output current/voltage. Normally, very small rotation will provide large changes on output.

CAUTION: ***DO NOT adjust other trimmer potentiometers, (factory adjustment only).***

4.11. Cable installation

WARNING: ***BEWARE OF HIGH VOLTAGES ON THE STATOR BARS (5...22 KV). DO NOT ATTACH TRIAXIAL CABLE DIRECTLY TO THE STATOR BARS.***

THE TRIAXIAL CABLE, PREAMPLIFIER AND MULTICORE SHIELDED CABLE MUST BE PROTECTED BY A FLEXIBLE OR SEMI-RIGID POLYETHYLENE (PVC) CONDUIT.

CAUTION: ***The triaxial cable shall not be modified.***

Muticore shielded cable (between Preamplifier and Conditioner unit) may be shortened if neccesary.
Gently preshape the triaxial cable by hand to get the right form, avoid to bend it beyond a right angle.
Immobilize the triaxial cable inside The Air Gap to prevent vibrations and/or mechanical displacement:
-hold the triaxial cable temporary with Cyanoacrylate type glue, point-glued to the stator laminations (iron) surface.
-applly Silicone sealant along the cable in the Air Gap up to the exit making a strong permanent bond.

4.12. Connection to Conditioner unit AGSC

The figure illustrates how to connect the multicore cable to the Conditioner unit.

Pole profile output gives instantaneous air-gap value measured by the sensor. It is optocoupled and insulated from sensor ground and also from power supply negative. Output signal can be ordered as 0...20mA or 4...20mA.

NOTE: ***When 0...10V output is needed instead of 0...20mA (4...20mA), a current to voltage conversion resistor of 500 ohms should be placed at the end of line near the acquisition unit (lower noise level).***

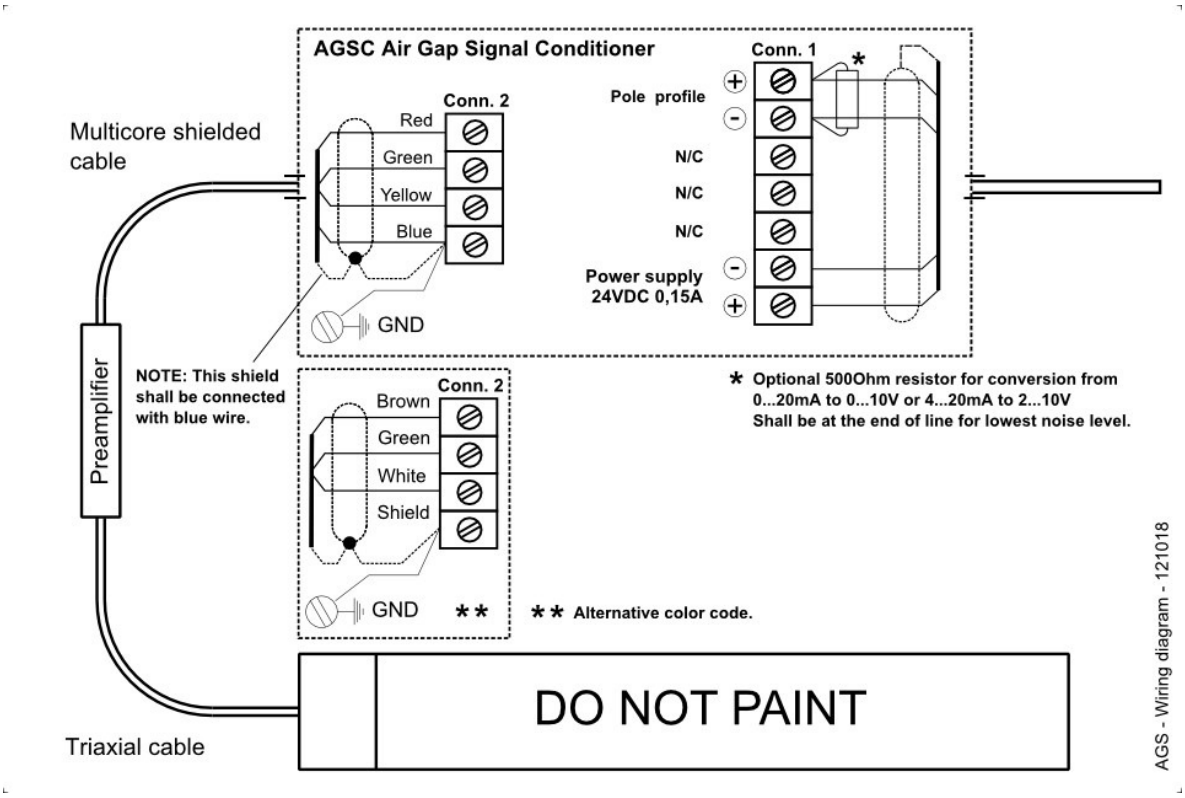


Figure 12: AGS Wiring diagram

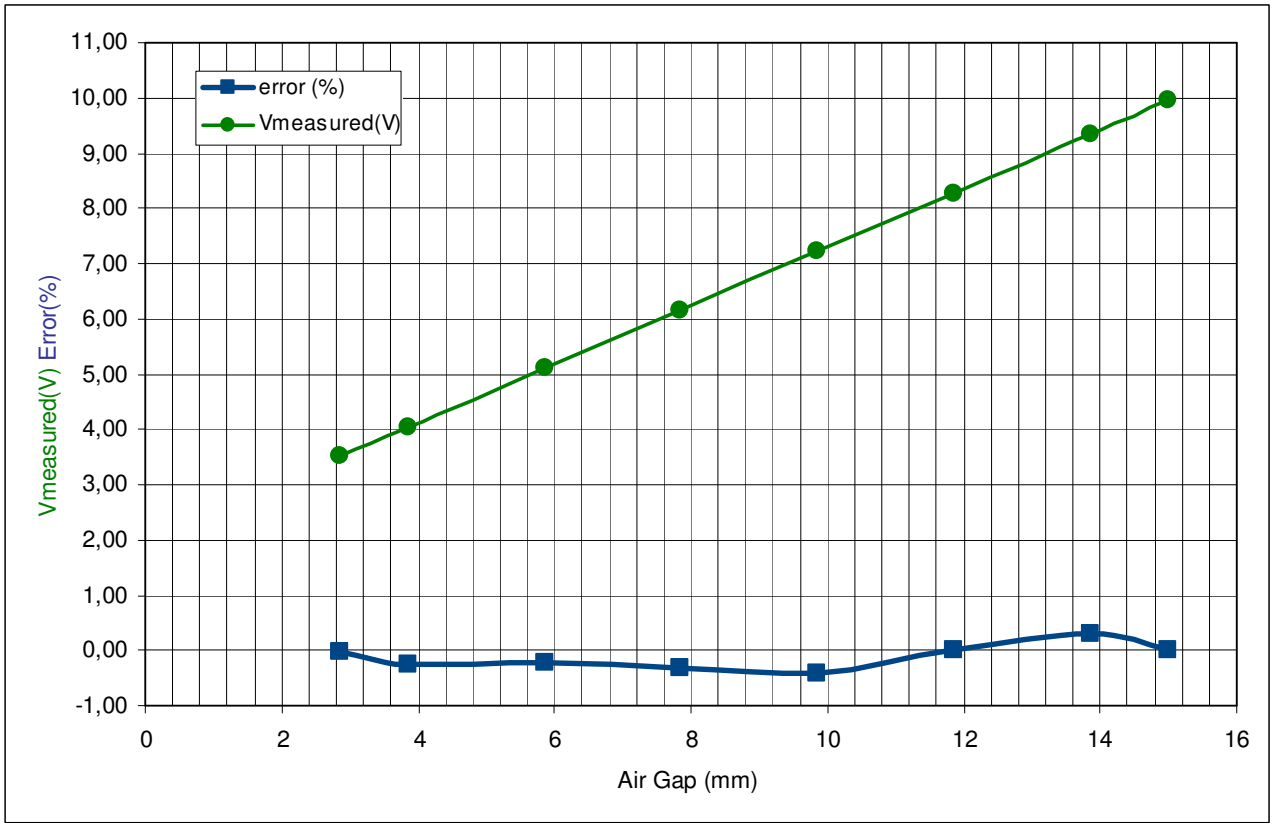
Air Gap (mm)	Iout (mA)	Vout (V) at 500 Ohm
0	0	0
2	4	2
10	20	10

Table 1. AGS-10, 0...20mA, 2mA/mm, Output example

Air Gap (mm)	Iout (mA)	Vout (V) at 500 Ohm
0	4	2
2	7,2	3,6
10	20	10

Table 2. AGS-10, 4...20mA, 1,6mA/mm, Output example

4.13. Typical linearity diagram



5. Troubleshooting

Pole profile Output signal higher than 20mA or 10V:

Check the distance to pole surface is within measuring range.
If this happens during replacement of a new sensor slowly turn Offset adjustment trimmer potentiometer (inside Conditioner unit) until reaching desired output.

2. Pole profile Output signal to low:

A. If this happens during **replacement** of a new sensor slowly turn Offset adjustment trimmer potentiometer inside Conditioner unit until reaching desired output.
B. If this happens during **normal working** conditions check Sensor or Triax cable for damages.

3. 50 or 100Hz Noise in pole profile signal:

A. Check grounding scheme. Ground loops shall be avoided.
B. AGS Conditioner unit will tolerate aprox 0,1 Tesla of stray magnetic fields. If stronger fields are present use aditional protection box made from ferromagnetic material or move to other location.

6. Important notice

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